

Weather Clim. Dynam. Discuss., referee comment RC1
<https://doi.org/10.5194/wcd-2021-17-RC1>, 2021
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Comment on wcd-2021-17

Anonymous Referee #1

Referee comment on "A global analysis of the dry-dynamic forcing during cyclone growth and propagation" by Philippe Besson et al., Weather Clim. Dynam. Discuss.,
<https://doi.org/10.5194/wcd-2021-17-RC1>, 2021

In this manuscript the authors investigate the dry-dynamics forcing influencing extratropical cyclones growth and propagation direction. Specifically, this is done by analyzing the Eady Growth Rate (EGR) and the QGw forcing along the cyclone tracks. Overall, this is a well-written paper that presents interesting results. However, I was missing some more theoretical basis and motivation for the choice if these two diagnostics. Most of the conclusions of this study are not really surprising (and generally agree with previous studies), but the paper is still interesting and deserves publication after some revision. My comments are given in more detail below.

Main comments:

- I am not sure what is the benefit of using the two diagnostics above (namely, EGR and QGw), as opposed to, for example, a PV tendency equation. I was missing a more theoretical basis and motivation for the choice if these two diagnostics. Also, how do these relate to terms appearing in the PV tendency equation? For example, for the QGw term, is this essentially the vertical advection wq/dt ? For the EGR term, I think you should discuss more what it represents and how it relates to earlier studies (e.g., from a PV perspective). What is the equation in which EGR enters as a forcing term? Does this term essentially represents the induced meridional advection by the upper level PV? It seems to me like less can be learned on the actual dynamics by looking at these two diagnostics alone. So I think you should at least elaborate on your choices for diagnostics in the introduction and methods, and which equation motivates your analysis.

- Section 3.1: perhaps you should show first density maps of along track E and Q regions separately (or do these just look very similar to the climatological fields given in the supplementary information?).

- Fig. 2a: The high Q and low E that occur at the downstream regions of the storm tracks- perhaps these are related to secondary (downstream) cyclogenesis?

- Section 3.2: You can just plot the averaged Q and E as a function of normalized time to support these findings.

- Would diabatically forced cyclones enter the low Q and low E group? If so, I would still expect to find high deepening rates for this cluster.

- The fact that the regions of maximum deepening in the two oceanic basins coincide with local maxima in mean poleward propagation angles is not surprising, and entirely agrees with previous studies that showed the role of the westward tilt (through induced meridional advection) and diabatic heating to the poleward propagation (e.g., Rivière et al. 2012, Coronel et al., 2015; Tamarin and Kaspi, 2016).

- Fig. 9d: It seems like the jet in this case is contributing more to zonal advection.

- As you state: "it is difficult to judge what the exact contribution by the EGR environment is to the cyclone's propagation". I think this is because the EGR measure mixes the zonal (through U) and meridional (through the induced advection) influences. On the one hand, I would expect more poleward propagation where EGR is high (since this implies westward tilt and hence poleward advection by the upper level PV), but high EGR also implies strong zonal advection. This is why I think the EGR diagnostic is not very helpful for studying the propagation angles.

- QGw influence on propagation (the results you describe when discussing Fig.9a,b)- can you explain why this is what we find? what is the underlying mechanism?

- In general, throughout the paper, I was missing a discussion (beyond describing your results) of what the underlying mechanisms are.

Minor comments:

- Line 47: turns=turn

- Line 70: Wrong citation here. The relevant citation here should be: T. Tamarin-Brodsky and Y. Kaspi, "Enhanced poleward propagation of storms under climate change", *Nat. Geosci.*, 10.1038/s41561-017-0001-8 (2017).

- Line 335: I think you meant Fig. 9a.